Our experiences in emergency surgery for proximal aortic diseases

Emergency surgery of proximal aortic diseases

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Abstract

Aim: Proximal aortic disease surgery has high morbidity and mortality. In addition, the urgent performance of these operations complicates both surgical and anesthesia management. This study aimed to retrospectively evaluate patients with proximal aortic diseases who were operated on urgently in our cardiovascular surgery department.

Material and Methods: After approval was obtained from the ethics committee, a total of 72 patients who underwent emergency proximal aortic surgery in our clinic between January 2014 and January 2020 were analyzed retrospectively. Demographic data, comorbidities, anesthetic agents administered, mean duration of anesthesia, cardiopulmonary bypass (CPB) time, X-clamp time, intensive care and hospitalization times, mortality, and morbidity were evaluated.

Results: There were 51 (70.83%) male and 21 (29.17%) female patients. The mean age of the patients was 62.31±11.71 years. The most common preoperative risk factor was hypertension (n=60, 83.33%). Mean CPB time was 141.72±25.08 minutes. Fifty-nine patients (81.95%) survived and 13 (18.05%) died. The mean age of non-survivors (69.54±6.04 years vs. 60.71±12.09 years) was higher, and their X-clamp and CPB durations were longer compared to surviving patients.

Discussion: It is essential to determine the causes of mortality, take precautions, and share positive and negative experiences in both anesthesia and surgical management of proximal aortic pathologies that are operated on urgently. Hemodynamic instability, additional surgical procedures, and prolonged operation and perfusion times are key factors affecting mortality and morbidity.

Keywords

Proximal Aortic Diseases, Emergency Surgery, Anesthesia

Introduction

Emergency anesthesia is anesthesia administered in unplanned, non-elective surgical procedures [1]. As in other surgical branches, surgeries that require emergency intervention in cardiovascular surgery are increasing. Anesthesia management of cardiovascular diseases that require emergency intervention necessitates vast knowledge of cardiovascular physiology, as well as how different anesthetic agents affect pulmonary and systemic circulation and myocardial functions. The necessity of urgent operation complicates the management of anesthesia since it also limits the preparations and preoperative evaluation [2, 3].

In addition to the risk of a full stomach in patients undergoing emergency surgery, systemic diseases such as asthma, diabetes mellitus, hypertension, hypovolemia, and electrolyte disorders that cannot be evaluated adequately preoperatively and abnormal laboratory values all increase the risks of anesthesia [1, 4]. These problems should be determined as carefully as possible during the planning phase and precautions should be taken.

The frequency of aortic diseases requiring urgent intervention has increased due to easier access to healthcare services, the development of technology, and the increase in the elderly population [5]. Proximal aortic dissection and aneurysms are aortic diseases that may require emergency intervention by open heart surgery. Despite medical and technological advances, mortality and morbidity rates are also quite high [6, 7].

One of the key factors in increasing the success of these surgeries is the transfer of experience through clinical studies, and another is the protocol-oriented optimization of the results from these experiences specific to aortic surgeries. In this study, we aimed to retrospectively evaluate the results of our patients with proximal aortic dissection and aortic aneurysms who were operated on urgently and hence contribute to the literature.

Material and Methods

Study Plan and Patient Selection

The study was retrospectively performed with 72 patients with proximal aortic diseases who underwent emergency operations between January 1, 2014, and January 1, 2020, after the approval of the local ethics committee was obtained and in accordance with the Declaration of Helsinki. Demographic data, comorbidities, anesthesia, cardiopulmonary bypass (CPB) time, X-clamp time, total circulatory arrest, amounts of blood and blood products transfused, intensive care and hospitalization times, and morbidity and mortality were examined. Patient data were accessed through patient files and the hospital registry. Patients under 18 years of age who underwent elective surgery due to proximal aortic diseases and those who would undergo redo open heart surgery were excluded.

Routine Anesthesia Procedure

The patients were assessed preoperatively with the available data. Intravenous cannulas were placed in the operating room before anesthesia induction. Routine monitoring included electrocardiography with leads D2 and V5, SpO2 measurement with pulse oximetry, and invasive systemic arterial pressure, end-tidal carbon dioxide (ETCO2), esophageal temperature, invasive arterial blood pressure, and right atrial pressure measurement with central venous catheters. In addition, arterial blood gas and urine output were monitored hourly. Anesthesia induction drugs and doses administered according to the hemodynamic status of the patients were as follows:

• 1-2 μg/kg fentanyl (Talinat, Vem Pharmaceuticals, Turkey), 3-5 mg/kg pentothal (pental sodium vial, İbrahim Etem Pharmaceuticals, Turkey), and 0.6 mg/kg rocuronium (Myokron, Vem Pharmaceuticals, Turkey), in hypertensive patients.

• 1-2 μg/kg fentanyl (Talinat, Vem Pharmaceuticals, Turkey), 2 mg/kg propofol (propofol Fresenius vial, Germany), and 0.6 mg/kg rocuronium (Myokron, Vem Pharmaceuticals, Turkey), in hypertensive patients.

• 1 mg/kg ketamine (Ketax, Vem Pharmaceuticals, Turkey), 0.05-0.1 mg/kg midazolam (Zolamid, Vem Pharmaceuticals, Turkey), and 0.6 mg/kg rocuronium (Myokron, Vem Pharmaceuticals, Turkey), in hypotensive patients.

In the maintenance of anesthesia, in addition to a 50% O2 and air mixture, sevoflurane inhalation anesthesia was administered with a minimum alveolar concentration of 0.5-1.5%, and additional intravenous fentanyl, midazolam, and rocuronium maintenance doses were given (3-5 μg/kg, 0.02 mg/kg, and 0.01 mg/kg, respectively). Furosemide was administered at 0.3 mg/kg to patients with urine outputs of less than 0.5 mL × weight/hour. The perioperative hemodynamic findings of the patients and the drugs administered were recorded on anesthesia follow-up charts and perfusionist follow-up slips during CPB.

Routine Cardiopulmonary Bypass Management

Priming solution, including crystalloid liquid, mannitol, 8.4% sodium bicarbonate, erythrocyte suspension according to the patient's hematocrit value, and 150 units/kg of unfractioned heparin (Koparin vial, Koçak Pharmaceuticals, Turkey), was used for extracorporeal circulation. Systemic heparinization was achieved with 300 units/kg of intravenous heparin (Koparin vial, Koçak Pharmaceuticals, Turkey). Activated clotting time (ACT) was measured for anticoagulation assessment. When ACT was >450, CPB was initiated.

Patients underwent either deep (22-25 °C) or moderate hypothermia (25-28 °C) [8, 9]. Age, preoperative kidney function, and aortic pathology were effective in deciding the level of hypothermia. The subclavian, axillary, aortic, and femoral arteries were used for arterial cannulation, the choice of which was influenced by the surgical pathology and the preference of the surgeon. Cardiac arrest was achieved with either crystalloid or del Nido blood cardioplegia. Myocardial protection was accomplished with cold blood cardioplegia in patients receiving crystalloid cardioplegia for cardiac arrest and with del Nido blood cardioplegia solution in those receiving del Nido blood cardioplegia. The pump flow was stopped as necessary for the repair of the aortic arch. At this time, cerebral perfusion was performed for cerebral protection. After the aortic repair, the CPB termination phase was initiated. If necessary, an inotropic agent such as dopamine, dobutamine, adrenaline, or noradrenaline was administered to restart the heart. Nitroglycerin was the vasodilator agent administered to the patients. After the CPB was terminated, anticoagulation was achieved by intravenous administration of protamine at a dose of 350 units/kg (Promin, Vem Pharmaceuticals, Turkey).

Routine Postoperative Procedure

After the operation ended, the intubated patients were transported to the intensive care unit, where they were extubated by weaning if their hemodynamics were stable.

Statistical Methods

Data were evaluated with SPSS 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used for basic statistical analysis and data were presented as mean±standard deviation and percentage. The Mann-Whitney U test was used for intergroup comparisons of non-normally distributed continuous variables and the chi-square test was used for categorical variables.

Results

The files of 72 patients who were urgently operated on by the cardiovascular surgery team were retrospectively evaluated. The number of male patients (n=51, 70.83%) significantly exceeded that of females (n=21, 29.17%) (p<0.05). The mean age of all patients was 62.31±11.71 years. Hypertension was the most common comorbidity in all patients with a rate of 83.33% (n=60). Other comorbidities included diabetes mellitus (n=27, 37.50%), coronary artery disease (n=22, 30.55%), cerebrovascular disease (n=5, 6.94%), and smoking (n=44, 61.11%).

Table 1. Demographic data and comorbidities

Parameters	Survivors (n=59)	Non-Survivors (n=13)	p
Female, n (%)	21 (35.59)	0 (0)	-
Male, n (%)	38 (64.41)	13 (100)	<0.05
Age, years, mean±SD	60.71±12.09	69.54±6.04	<0.05
Height, cm, mean±SD	174.07±6.69	177.31 ±4.25	>0.05
Weight, cm, mean±SD	81.68±12.82	86.69 ±5.36	>0.05
ASA class 3, n (%)	17 (28.81)	4 (30.77)	>0.05
ASA class 4, n (%)	42 (71.19)	9 (69.23)	>0.05
Hypertension, n (%)	49 (83.05)	11 (84.61)	>0.05
Diabetes mellitus, n (%)	22 (37.29)	5 (38.46)	>0.05
CAD, n (%)	18 (30.51)	4 (30.77)	>0.05
COPD, n(%)	12 (20.34)	3 (23.08)	>0.05
CVD, n (%)	4 (6.78)	1 (7.69)	>0.05
Smoking, n (%)	36 (61.02)	8 (61.54)	>0.05

CAD: Coronary artery disease, COPD: chronic obstructive pulmonary disease, CVD: cerebrovascular disease, ASA: American Society of Anesthesiologists.

Table 2. Intraoperative data

Parameters	Survivors (n=59)	Non-Survivors (n=13)	p
Isolated aortic repair, n (%)	26 (44.07)	1 (7.69)	<0.05
Aortic repair + additional surgery, n (%)	33 (55.93)	12 (92.31)	<0.05
Duration of anesthesia, min, mean±SD	303.56±40.84	315.69±35.73	>0.05
CPB duration, min, mean±SD	138.83±23.98	154.85±26.77	<0.05
X-clamp duration, min, mean±SD	93.83±13.28	102.31±12.41	<0.05
TCA, n (%)	15 (25.42)	4 (30.77)	>0.05
Moderate hypothermia, n (%)	31 (52.54)	6 (46.15)	>0.05
Deep hypothermia, n (%)	28 (47.46)	7 (53.85)	>0.05
Hemodynamic instability, n (%)	17 (28.81)	12 (92.31)	<0.05
Inotrope infusion treatment, n (%)	6 (10.17)	12 (92.31)	<0.05
Units of ES transfused within the first 24 hours, mean±SD	3.78±2.31	6.61±1.61	<0.05

CPB: Cardiopulmonary bypass, TCA: total circulatory arrest, ES: erythrocyte suspension.

The comorbidities of the survivors and non-survivors were similar (p>0.05) (Table 1). The male gender was significantly more predominant (p<0.05) (Table 1). The mean age of the non-survivors was significantly higher than that of survivors (p<0.05) (Table 1).

General anesthesia was administered to all patients. The pentothal-fentanyl-rocuronium combination was most commonly used in induction (n=42, 58.33%). The propofol-fentanyl-rocuronium combination was administered to 18 patients (25%) and ketamine-midazolam-rocuronium was administered to 12 (16.67%). Midazolam-fentanyl-rocuronium was used for all patients for anesthesia maintenance.

Twenty-seven patients (37.5%) underwent isolated aortic repair surgery and 45 (62.5%) underwent an additional surgical procedure (aortic valve repair, mitral valve repair, coronary artery bypass graft surgery) besides aortic repair. The incidence of receiving an additional surgery was significantly higher among non-survivors than surviving patients (p<0.05) (Table 2). Among all patients, the mean duration of anesthesia was 305.75±40.01 min, the mean CPB time was 141.72±25.08 min, and the mean X-clamp time was 95.36±13.45 min. Twenty-nine patients (40.28%) had hemodynamic instability and inotrope infusion was administered to 18 (28%). The mean cardiopulmonary bypass time and X-clamp time, hemodynamic instability, and inotrope infusion administration rates were significantly higher among non-survivors (p<0.05) (Table 2). The mean erythrocyte suspension transfused was 4.29±2.45 units among all patients, being significantly higher among non-survivors compared to those who survived (p<0.05) (Table 2). Moderate and deep hypothermia were administered to 37 (51.39%) and 35 (48.61%) patients, respectively, with no significant differences between the survivors and non-survivors (p>0.05) (Table 2).

All patients were postoperatively transferred to the cardiovascular surgery intensive care unit. The mean length of stay in the intensive care unit was 3.43±2.07 days and the mean hospital stay was 7.93±2.97 days. Neurological complications, bleeding, infection, arrhythmias, and renal failure were observed in 13.89% (n=10), 9.72% (n=7), 6.94% (n=5), 8.33% (n=6), and 4.17% (n=3) of the patients, respectively. Mortality was seen in 13 patients (18.05%), the reasons being low cardiac output in 6 (46.15%), multi-organ failure in 4 (30.77%), bleeding in 3 (23.08%), and febrile reaction in 1 (7.69%) patient.

Discussion

Emergency anesthesia is administered in unplanned, non-elective surgical procedures [1]. These patients cannot be fully evaluated preoperatively due to time constraints [2, 3]. In patients who will undergo emergency surgery, in addition to the risk of aspiration pneumonia that may occur due to a full stomach, the risk of anesthesia increases due to inadequate preoperative evaluation of systemic diseases such as asthma, diabetes mellitus, hypertension, hypovolemia, and electrolyte disorders and laboratory values. These problems should be determined as much as possible during the planning phase and precautions should be taken [2, 4].

Anesthesiologists play a vital role with the surgical team in improving the outcome of high-risk and emergency cases.

For successful anesthesia management and perioperative outcomes, basic knowledge of the surgical procedure, thorough preoperative emergency assessment, early surgical intervention if possible, and careful planning of fluid-electrolyte support and pain management are necessary [3, 4]. Dissection and aneurysms, which are among the proximal aortic diseases, constitute an important part of cardiovascular surgeries in which emergency anesthesia is administered.

Although aortic dissections and aneurysms can be observed across all ages, they are more common among the elderly and males [10, 11]. In our study, the mean age of the patients was 62.31±11.71, 70.83% were male, and 29.17% were female. In addition, the mean age of our non-surviving patients was higher than that of survivors (Table 1).

Factors such as congenital anomalies (Marfan syndrome, Ehler-Danlos syndrome), cystic medial necrosis, hypertension, pregnancy, atherosclerosis, inflammatory diseases (giant cell arteritis, autoimmunity), and trauma are held responsible in the etiology of aortic dissections and aneurysms [12-15], and hypertension is reportedly the most common [6, 7]. In our study, hypertension was the most common predisposing factor among both survivors and non-survivors, with an overall rate of 83.33% (Table 1). Hypertension was followed by smoking (61.11%) and diabetes mellitus (37.5%).

As in all other cases, during surgeries for aortic pathologies, the anesthetist should provide the surgeon with optimum working conditions with good hemodynamic stability, adequate depth of anesthesia, and muscle relaxation. Since the pathology of patients with cardiac diseases will directly affect the sympathetic nervous system and the intravascular volume status, the anesthetic approach should be determined accordingly [16]. Therefore, whether the primary pathology of the proximal aorta involves an aneurysm, dissection, or rupture will affect the anesthetic approach. While hypertension should be managed in patients with aortic aneurysm and dissection, hypotension should be controlled in the case of a ruptured aorta. Endotracheal intubation and laryngoscopy, which should be performed immediately in cardiac emergencies for airway safety, will cause sympathetic stimulation, leading to hypertension and tachycardia [17]. Therefore, it is necessary to choose the anesthetic agent according to the primary pathology and the clinical condition of the patient and to have vast knowledge about the effects of these agents. Propofol and thiopental cause hypotensive effects, while ketamine increases blood pressure [16]. In our study, the most common combination used for anesthesia induction was pentothal-fentanyl-rocuronium at a rate of 58.33%. Midazolam-fentanyl-rocuronium was used for all patients during maintenance.

In aortic dissections and aneurysms, emergency surgical intervention is the main treatment, regardless of whether serious complications have developed. The aim of surgical treatment is resection of the aneurysm or dissected part of the aorta and graft repair. In some patients, additional surgical procedures such as heart valve replacement and coronary grafting may be performed depending on the location and degree of pathology [18]. In our study, 62.5% of the patients underwent additional surgical procedures.

The high probability of intraoperative instability of hemodynamic parameters in these patients makes it important to have inotropic agents available in the operating room. In our patient group, hemodynamic instability was observed at a rate of 40.28% and inotropic agents were used in 25% of cases. In addition, both possible blood loss and hypothermia increase the need for blood and blood products [19, 20]. To ensure hemodynamic stability, blood and blood products should be transfused immediately when needed, which necessitates their preparation preoperatively [21]. In our study, the mean amount of erythrocyte suspension transfused within the first 24 hours was 4.29±2.45 units.

Hypothermia is achieved locally or systemically in patients during open heart surgery [22], especially congenital heart surgery [23] and aortic surgery [24]. Systemic hypothermia is used in patients during aortic surgery [24]. All patients in our study underwent hypothermia, as recommended for open heart surgery and aortic surgery in the literature. While hypothermia was moderate in 51.39%, it was deep in 48.61%. The hypothermia practices were similar between the survivors and non-survivors (p>0.05) (Table 2).

Operation time, CPB time, X-clamp time, and total circulatory arrest time are important parameters that affect postoperative outcomes. Relationships between mortality and morbidity and the lengths of these periods were shown in previous studies [7, 25, 26]. In our study, the durations of CPB and X-clamp were longer among non-survivors (Table 2). We think that additional surgeries also play an important role in prolonging the duration, as the rate of additional surgeries performed was significantly higher among non-survivors compared to survivors (Table 2). Intraoperative hemodynamic instability and the rate of inotropic infusion administration were also higher in these patients (Table 2).

Extracorporeal circulation in open heart surgery physiopathologically affects multiple organs such as the brain, lungs, kidneys, and liver. The anesthesiologist's preservation of hemodynamic stability perioperatively prevents organ dysfunction [19]. Adequate cerebral perfusion is essential in the surgical treatment of proximal aortic pathologies because neurological complications may cause postoperative mortality and morbidity. In their study on the factors affecting mortality and morbidity of type A dissections, Engin et al. found that permanent neurological damage developed in 10.7% of their cases [7]. Similarly, in our study, the rate of permanent neurological damage was 13.89%.

Studies on the surgical treatment of ascending aortic diseases report low cardiac output and multi-organ failure as important mortality factors [7, 27, 28]. In the study of Ceviz et al. on the surgical treatment and early results of proximal aortic dissections in a series of 45 patients, left ventricular dysfunction and multi-organ failure were found in 7 patients (15.5%) and 1 patient (2.2%), respectively [27]. In our study, low cardiac output and multi-organ failure were the most common causes of mortality with rates of 46.15% and 30.77%, respectively.

The retrospective nature and small sample size are the main limitations of our study. We think that sharing the results of prospective studies conducted with more patients on this subject will contribute to the literature.

Although advanced diagnostic tools currently enable faster

diagnosis due to technological advancements, the mortality and morbidity of emergency proximal aortic diseases remain challenging. Determining the mortality and morbidity factors and taking precautions in such cases will positively affect the outcomes. It is essential for the anesthesiologist to quickly identify the preoperative comorbidity factors, plan the approach, and ensure intraoperative hemodynamic instability. Operating on the patient as soon as the surgical diagnosis is made, avoiding additional surgical procedures as much as possible, and keeping the operation and perfusion times as short as possible are of great importance. In addition, as in all other cardiovascular emergencies, we think that the clinical experience of the surgical and anesthesiology team, as well as their close cooperation and multidisciplinary approach, will positively affect the postoperative results of these patients.

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